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Fluids and Combustion Facility Document

Procedure for EPCU Control and Load Control Software

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Approved by Robert Zurawski, FCF Project Manager, Microgravity Science Division, 6700

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1.0 INTRODUCTION

The Electrical Power Control Unit (EPCU) control and load Ground Support Equipment (GSE) is used to test flight and non-flight EPCUs. This procedure describes the GSE to EPCU test unit hardware interfaces, along with software command instructions that allow a single EPCU to be tested under various operational configurations and load conditions described in this procedure. The EPCU is used by the Fluids and Combustion Facility (FCF) as the electrical power distribution system in support of payloads integrated into the FCF flight racks.

1.1 Purpose

The purpose of this procedure is to provide EPCU test personnel with instructions for set-up and operation of the EPCU control and load GSE.

1.2 Scope

This procedure is to be used when testing flight and non-flight EPCUs interfaced to the EPCU control and load GSE.

2.0 REFERENCES

2.1 Reference Documents

Document Number	Document Title
771125	EPCU Outline Drawing (Hamilton Sundstrand)
771129	EPCU Assembly Drawing (Hamilton Sundstrand)
FCF-PO-SPEC-0010	EPCU Specification

2.2 Records and Forms

There are no records or forms related to this process.

2.3 Acronyms

Acronym	Definition
DDE	Dynamic Data Exchange
EPCU	Electrical Power Control Unit
FCF	Fluids and Combustion Facility
FRPC	Flexible Remote Power Controller
GSE	Ground Support Equipment

2.4 Definition of Terms

Term	Definition
Control Computer	Ground support equipment used to operate the EPCU.
DDE Server/Software	Software application that establishes and maintains communication between the control computer and GSE.
Electrical Power Control Unit (EPCU)	Unit under test in this procedure. The EPCU is used by the FCF as the electrical power distribution system in support of payloads integrated into the FCF flight racks.
EPCU Control Software	Software application that establishes and maintains communication between the control computer and EPCU.
Flexible Remote Power Controller (FRPC)	Solid state current-limiting power switch; 4 amps per channel; parallelable up to 16 amps.
Ground Support Equipment (GSE)	Non-flight hardware used to conduct the test; test equipment listed in Section 2.5.

2.5 Test Equipment

Part No., NASA I.D.	Equipment Description
Powerten Inc. NASA #: 1888664 NASA #: 1746248	GSE 120 V Power Supplies (140 Vdc – 44 amps) (Two)
Hyberlab Corp. PL3814X NASA #: 1747206	GSE EPCU Load Bank
	GSE EPCU Mil-Std-1553 Controller Cables J5 & J6
MS3459L28-22S (Connectors)	GSE EPCU Input Cables J1& J2
JAND 38999/26FG16PA (Connectors)	GSE EPCU 120Vdc Output Cables J3&J4
JAND 38999/26FG16PN (Connectors)	GSE EPCU 28Vdc Output Cables J11,J12
JAND 38999/26FG16PN (Connectors)	GSE EPCU 28Vdc Output Cables J13 thru J22
JAND 38999/26FG16PN (Connectors)	GSE EPCU 28Vdc Output Cable J22
38999/26FB35PN (Connector)	GSE EPCU On/Off Cable J7
Dell DCM S/N: 8NGF4 NASA #: 1746200	GSE Computer (Mil STD1553B and LonWorks Interface cards)
Gateway CPD-17F13 S/N: 2041222 NASA #: 1499960	GSE Computer Monitor
Dell SK-1000REW Part Number: 00081730	GSE Computer Keyboard

3.0 RESPONSIBILITIES

The Test Operator completes all steps in this process. This includes:

- EPCU test set-up
- Test equipment connection
- GSE computer console operation.

The Test Operator position requires a background in test engineering and familiarity with the EPCU hardware and operation.

4.0 PROCEDURE

4.1 Initial Connections

1. Connect EPCU 28Vdc output connectors JEPC11-22 to the 12 plastic connectors in the front panel of the 28 Vdc Load bank. These connectors are labeled channel 1 thru channel 48 (4 channels per connector). It is very important that these be connected as follows:
    - JEPC11 to connector 1-4
    - JEPC12 to connector 5-8
    - JEPC13 to connector 9-12
    - JEPC14 to connector 13-16
    - JEPC15 to connector 17-20
    - JEPC16 to connector 21-24
    - JEPC17 to connector 25-28
    - JEPC18 to connector 29-32
    - JEPC19 to connector 33-36
    - JEPC20 to connector 37-40
    - JEPC21 to connector 41-44
    - JEPC22 to connector 45-48
2. Connect EPCU JEPC7 to the cable with the small aluminum ON/OFF box. Keep the switch in the OFF position.
3. Set the address selection switches in this box such that switch # 6 is OFF and all the other switches are set to ON. This corresponds to a 1553 remote terminal address of 1 with odd parity.
4. Connect 1553 cable to EPCU JEPC5 or JEPC6. Connect the other end of the 1553 cable to the control computer. The 1553 connectors are labeled A or B in the computer. Use connector A.
5. Connect the Computer LonWorks interface cable to the instrumentation rack. This is the gray cable with yellow connectors at both ends. In the rack, the cable is connected to the bottom black box on the back panel. In the computer it is connected to the only slot that will fit the connector.
6. Connect EPCU JEPC3 and JEPC4 (120V outputs) to the 6 channels 120V resistive load bank. These are power resistors that are mounted in a bakelite plate that can be set on top of the instrumentation rack. Set the two fans close to the resistors for air-cooling.
7. Connect the EPCU JEPC1 and JEPC2 to two 120 V power sources. The instrumentation rack has two power supplies (Powerten), each capable of 140 Vdc and 44 amps DC. These power supplies are located at the bottom of the rack and they require 208VAC 3 phase power. If these power supplies are needed, their power terminals are available in the back panel of the instrumentation rack, via two pairs of (Supercon) connectors.

4.2 Control Computer Start-Up

1. Turn ON the control computer and monitor.
2. The first screen will ask for a user name and password; press CANCEL.
3. Once the computer has started up, it will show two icons in the center of the screen. One of them is DDE Server and the other is EPCU Control.
4. Turn ON the 28Vdc loads. This is a toggle switch in the lower right corner of the front panel of the load bank.
5. Double-click on the DDE Server icon. This will start the software to talk to the instrumentation rack and the 28Vdc loads. Press OK when the screen asks for it. Press OK again.
6. Once the DDE software has started, double click on the EPCU control icon to start the EPCU control software.
7. On the users list on the left select “Rlebron”. Then, on the password space, type “rlebron”
8. When this software has started, the screen will show a graphical interface that represents a block diagram of all the internal components of the EPCU and the 28Vdc loads. See Figure 1.

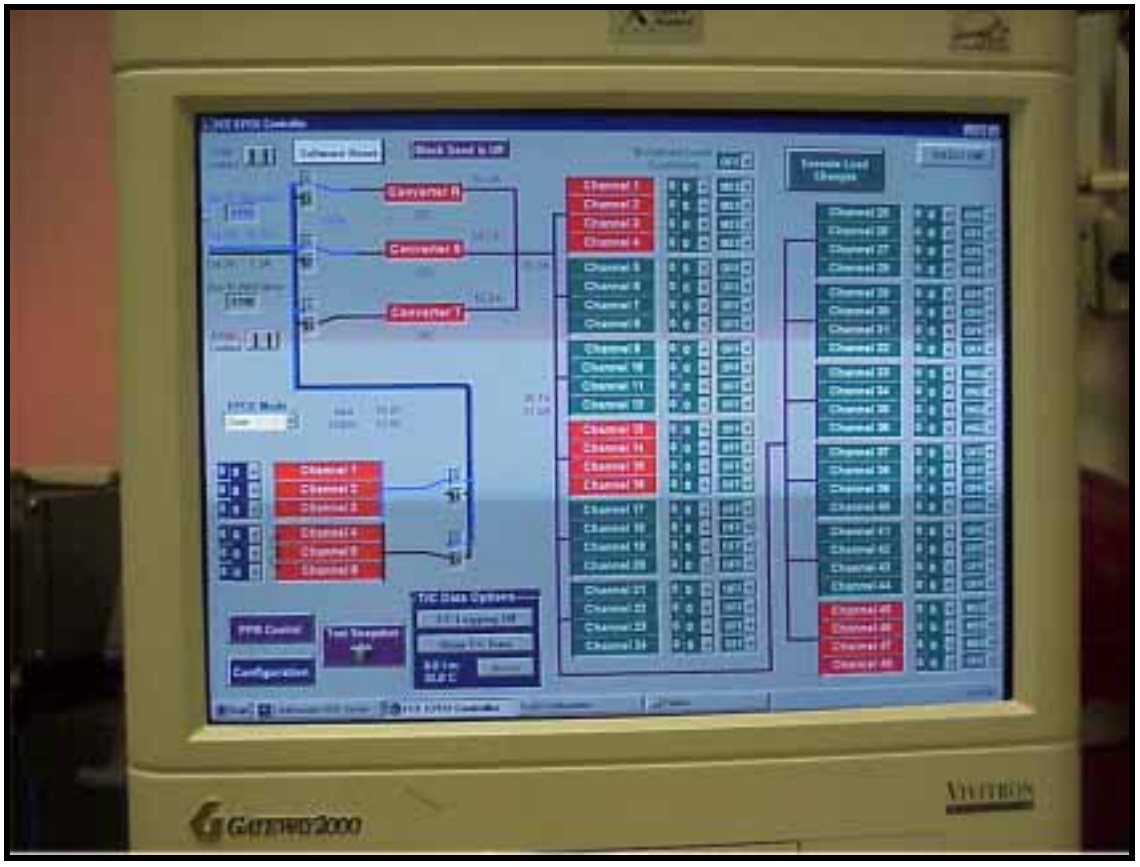

Figure 1 - EPCU Control Software Main Screen

9. At this point the control software can communicate with the instrumentation rack contactors and loads. However, it cannot communicate with the EPCU yet.

4.3 EPCU Start-Up

1. To apply 120 Vdc to the inputs of the EPCU turn ON the two (Powerten) power supplies at the bottom of the instrumentation rack. Set them to 120 Vdc.

2. Turn ON the ON/OFF key at the upper left hand corner of the front panel of the instrumentation rack. Push the red RESET button next to the ON/OFF key.

3. On the screen, click the button “P10A Contact” on the upper left corner. Also click the “P10B Contact” button. See Figure 2. These buttons will close the contactors that connect the 120V power supplies to the rack back panel (Supercon) connectors. This will provide 120 Vdc power to EPCU Bus A and Bus B. Verify that there is power on the EPCU input busses by observing the Bus A and Bus B power indicator in the front panel of the EPCU.

> **Note**: If the EPCU JEPC1 and JEPC2 are connected directly to the (Powerten) Power Supplies output terminals by not using the (Supercon) connectors in the back panel, or if some other power source is being used, then Steps 2 and 3 can be ignored as long as 120V power has been applied to the EPCU input terminals.

4. Go to the small aluminum ON/OFF box connected to JEPC7 and turn the EPCU ON by flipping the switch to ON. This will turn ON the housekeeping power supplies on the EPCU. This will cause the A13 FRPCs, the three 1kW converters, and all the initial position ON FRPCs (28Vdc and 120Vdc) to turn ON.

5. Up to this point the control computer is NOT communicating with the EPCU 1553 interface. To initialize this communication, in the control computer screen, click in the white rectangle button that is labeled “Software Reset”. This button is located in the upper left corner of the screen. See Figure 2.

6. Verify that the software is communicating with the EPCU by verifying that the three converters are ON (red color), and that the 1553 Input voltage data is updated every second and corresponds to the actual input voltage applied to the EPCU Input terminals. The output voltage data of the converters should also read approximately 28 Vdc. This will verify that the converters are ON. All of this information can be found in the upper left corner of the control software main screen. See Figure 2.

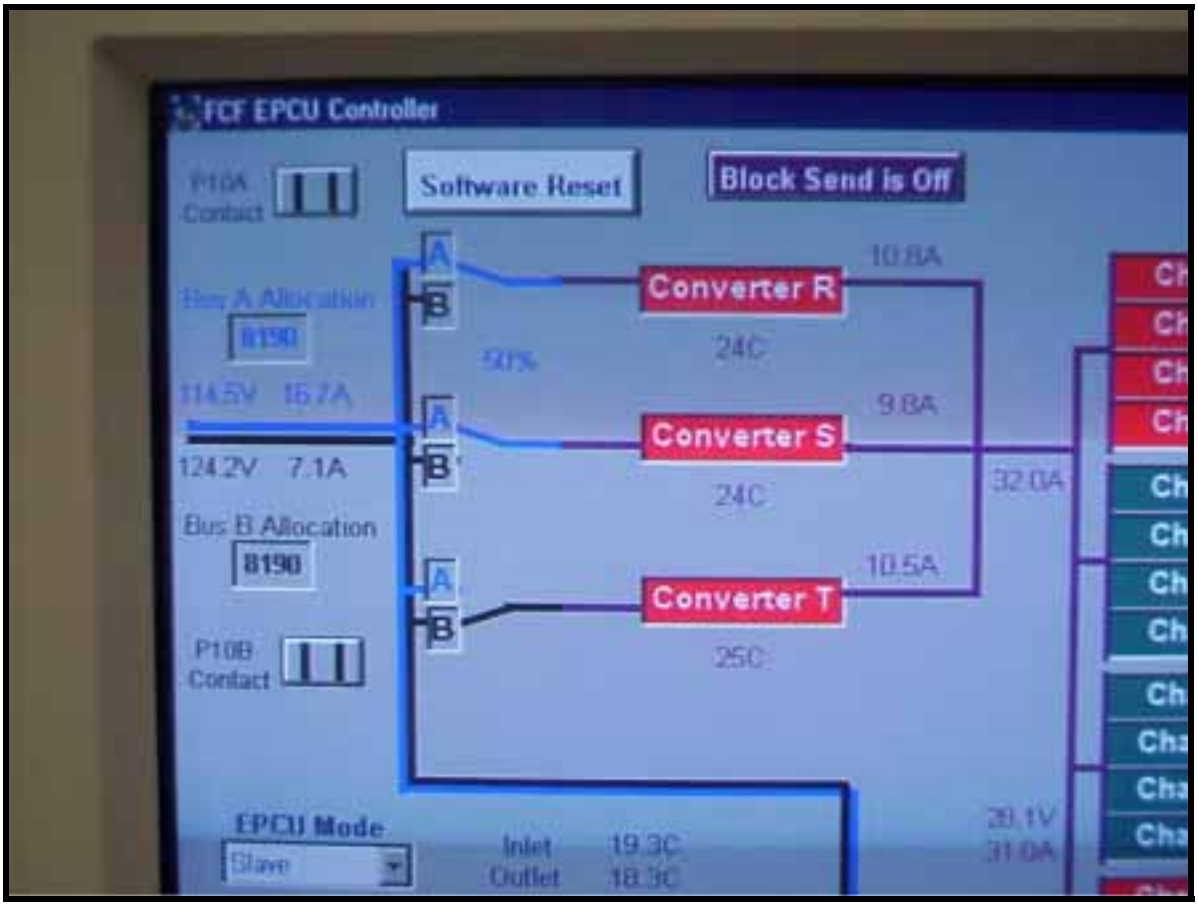

Figure 2 - Upper Left Corner of EPCU Control Software Main Screen

4.4 EPCU Input Allocation Setting, Converter Input Bus Selection and Converter Control

1. The first thing to do once the EPCU is running is to set the input allocation for Bus A and Bus B to its maximum value of 8190 Watts. This will ensure that the converters will share power. To do this, go to the upper left corner of the control software screen, see Figure 2. Go to the space under “Bus A Allocation”, and “Bus B Allocation”, type “8190” and press ENTER.

2. To set up the converters input bus configuration, go to the main screen upper left corner (see Figure 2). Each of the lines that feed each of the converters can go to A or B block (indicating A or B bus). To switch a converter from bus A to B, for example, simply click in the B box. The next EPCU status will report that the relay was transferred from input bus A to input bus B and the line will appear connected to B in the screen. This bus transfer operation can be performed with or without load in the converters because, before the relay transfer operation occurs, the A13 FRPC will automatically turn OFF momentarily and then turn back ON after the relay has changed its position.

3. The A13 FRPCs feeding each of the converters appears on the screen as a line connected to the input of the converter blocks, see Figure 2. To turn this FRPC off, just click this line and it will turn off the FRPC. When the A13 FRPC is OFF, it will appear as an open switch at the input of the converter block. To turn it back ON, click the open switch. The open switch will change to a straight line again, indicating an ON state.

4. In the control software screen, the converters are represented as rectangle boxes labeled R, S, and T. See Figure 2. In an OFF state their color is purple. In an ON state their color is red. To turn them OFF or ON, just click on the converter boxes and the change in color will indicate that the converter changed its state accordingly.

4.5 FRPCs Control, Priority Load Shedding, and Load Control

1. The 28 Vdc FRPCs appear in the control screen as rectangle boxes labeled channel 1 thru channel 48. See Figure 3. In an OFF state their color is green. In an ON state their color is red. To turn them ON or OFF, just click in the box and the change in color will indicate that the FRPC has changed its state accordingly.

2. When the FRPCs trip due to over-current, their color will turn to black. To reset the FRPC, click on it. It will change its color to green. To turn it back ON, click on it again. If the fault has been removed, the FRPC will turn ON and its color will change to red.

3. Next to the FRPC boxes there is a pull-down box with two numbers. The first number indicates the priority load shed setting for that FRPC; the next number is a pull-down menu where you can select a priority setting from 0 to 15. See Figure 3. 15 is the lowest priority setting, 0 means never trip on priority load shed. Once the setting has been selected, both numbers should match, that is, the first number will change to indicate that the new setpoint command was received by the EPCU.

4. If a priority load shed occurs, the FRPCs that trip will change their color to gray. To reset it, move the cursor on top of the “tripped” FRPC and click with the RIGHT button of the mouse. The FRPC box will change its color back to green. To turn it again, click on it (with the mouse left key as usual). If the over-allocation condition has been removed, the FRPC will turn ON and its color will change to red.

5. Next to the load shed priority setting is a pull-down menu that corresponds to the control for each of the 28Vdc loads. In this menu you can select OFF, Low (2 amps set-point), Med (2 amps set-point), and High (4 amp setpoint). To turn each load ON, simply select the set-point on its pull-down menu, and then click on the large green button labeled “Execute Load Changes” in the upper right corner of the screen. This button will actually send the command to the load. If the load was connected to the EPCU as explained in Section 4.1, Step 1 of this procedure, the load next to the FRPC in the screen will correspond to the load that is actually wired to that EPCU FRPC channel.

6. When the required FRPC channels have been commanded ON, verify that the total output current of the three converters correspond to the commanded 28 Vdc load. This current measurement can be found in Figure 2 just to the right of the point where the three converter outputs are tied together.

7. If all the loads will be commanded to the same setpoint, you can send a broadcast command by selecting the small pull-down menu at the top of the screen labeled as “Broadcast Load Command”, see Figure 3. For example, select “High” on the “Broadcast Load Command” menu and then click “Execute Load Changes” button to send the command. All of the 48 28 Vdc loads will be turned ON and set to 4 amps.

8. The 120V FRPCs are located in the lower left corner of the control screen. Their operation and control is similar to the operation and control of the 28Vdc FRPCs. The only difference is that these FRPCs color will be blue when OFF. But they will also turn red when turned ON.

9. To change the input bus that feeds a group of three 120V FRPCs (three FRPCs per connector) just click A or B at the desired FRPC group input. The switch in the screen will change its position to indicate that the Input bus feeding this group has changed.

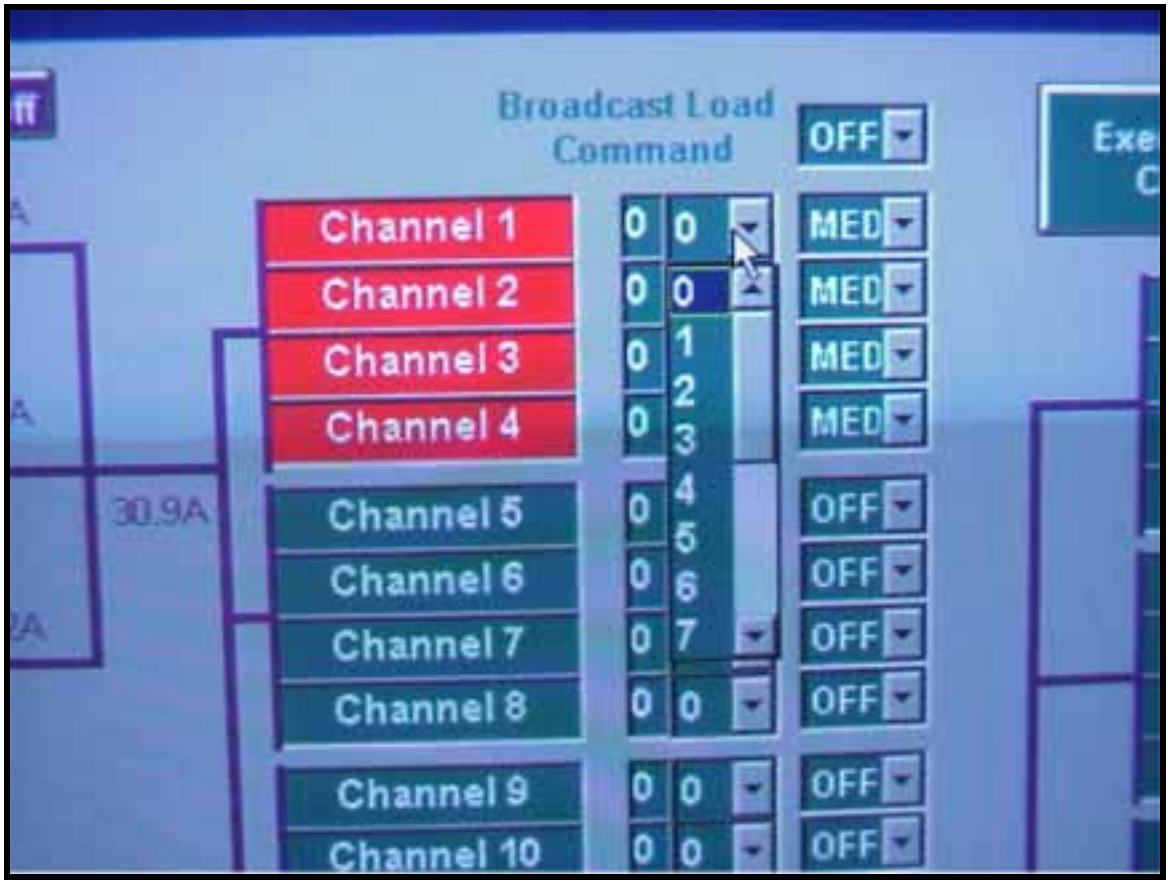

Figure 3 - FRPCs and Loads

4.6 FRPCs Paralleling and Initial Position Settings

1. To control FRPCs paralleling and initial position settings, click the blue button labeled "Configuration" at the lower left corner of the control software screen. See Figure 1. When this button is clicked, the screen will show a load configuration window as shown in Figure 4. This window allows the user to send commands to the 28Vdc load bank to achieve different EPCU configurations.

2. To parallel 28Vdc FRPC channel #1 with channel #2, click on the channel 1 box in the load configuration window. This will show a jumper connecting channel 1 and channel 2 to indicate that they are paralleled. To send this command to the load, click on the "Execute Configuration Changes" box in the load configuration window. This will send the paralleling command to the load. It is important to understand that this command will connect the power terminals (hot and return) of load 1 and 2 by means of relays. This will parallel the power terminals of EPCU 28 Vdc FRPC channel 1 and 2, only if the EPCU have been connected to the load as explained in Section 4.1 step 1 of this procedure. That is, channel 1 and channel 2 of the EPCU has been connected to Load #1 and Load #2 of the 28 Vdc load bank. This command will also tie the paralleling or personality pins of channel 1 and channel 2 of the EPCU at the load end. Therefore, they will act as an 8 amps FRPC and will turn ON and OFF by turning ON and OFF only channel 1. If a command is sent to channel 2, the parallel combination will ignore this command. If there is a trip, this parallel combination can be reset by resetting only channel 1.

3. Once this command is sent to the load, the EPCU will reflect the paralleling status of channels 1 and 2 by showing a jumper between channels 1 and 2 in the control software main screen.

4. To remove the paralleling, just click on channel 1 in the load configuration window and click "Execute Load Configuration Changes". The jumper between the two FRPC channels will disappear indicating that they are now two separate independent channels.

5. To add channels 3 and 4 to this parallel combination, simply click channel 2 and channel 3 in the load configuration window. Then click on "Execute Load Configuration Changes"; this will provide a 16 amps FRPC parallel combination.

6. To hide the load configuration window, simply click anyplace in the control software main screen outside of the load configuration window.

7. To set the initial position ON for the first 28Vdc FRPC channel of a connector, simply go to the load configuration window by clicking the "Configuration" button in the lower left corner of the control software main screen. Then click on the gray box below the connector needed that is labeled "IP OFF". The block will change its label to "IP ON". Then click on "Execute Load Configuration Changes". This will give the first 28Vdc FRPC channel of that connector an initial ON state on EPCU start-up. Of course, if there are other FRPCs in that connector that have been paralleled to the first, they will also turn ON with the parallel combination.

8. When the EPCU detects that the load has been configured to set an initial position ON for an FRPC channel, it will indicate this in the control software by showing a "P" inside the FRPC channel box in the control software main screen.

9. To remove the initial position ON condition, click the "IP ON" block and then click "Execute Load Configuration Changes" in the load configuration window. The P will disappear from the FRPC block in the main screen. This channel will now have an initial OFF position during EPCU start-up.

10. For 120Vdc FRPC channels, paralleling and Initial position are commanded manually by means of dip switches at the JEPC 3 and JEPC 4 break-out cables. The power terminals will have to be hardwired at the 120 Vdc load bank for parallel operation.

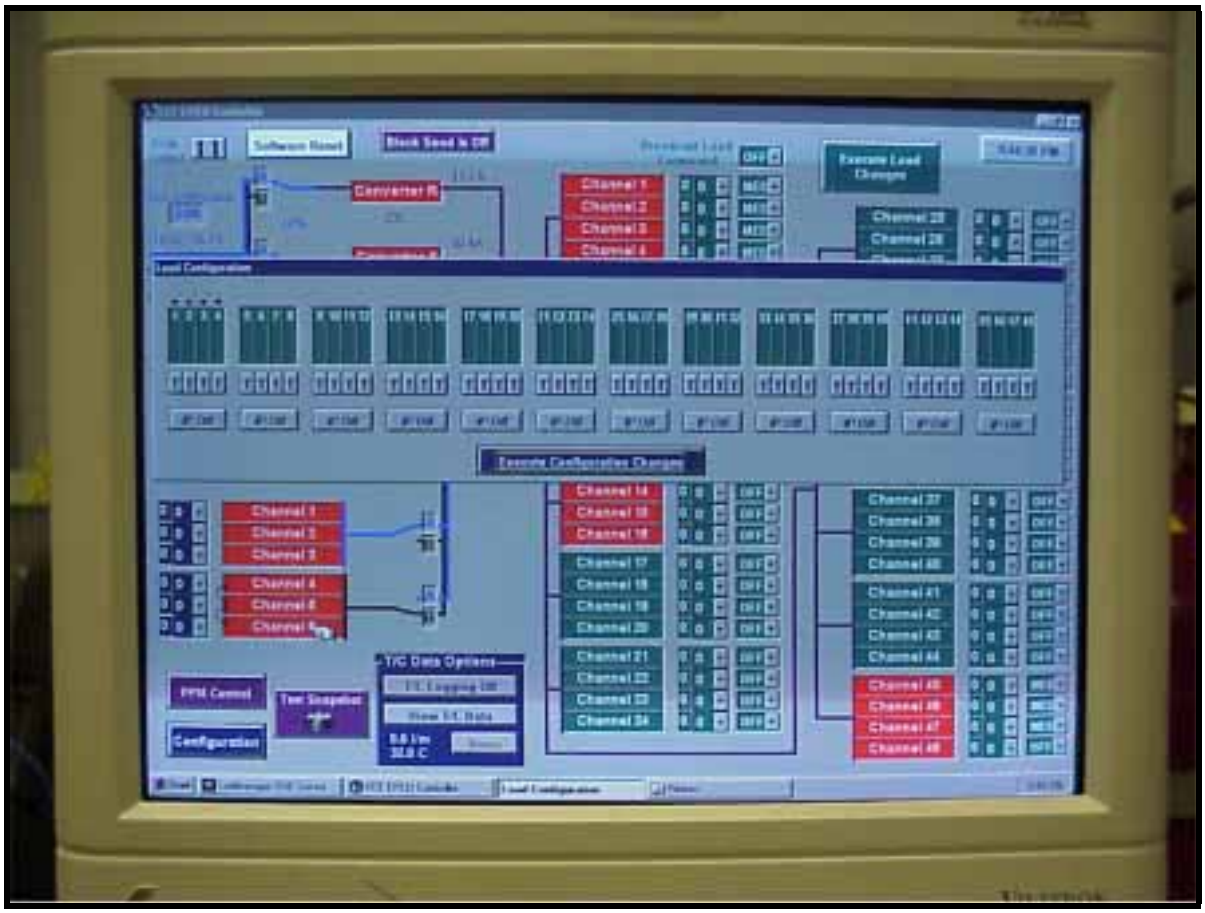

Figure 4 - Paralleling and Initial Position Configuration Screen